The GEWEX Radiative Flux Assessment Project

CERES Science Team Meeting
April 24-26, 2007

Presenter: Laura Hinkelman

Oversite committee: Atsumu Ohmura (ETH), Ehrhard Raschke (U. of Hamburg), William Rossow (NASA GISS), Paul Stackhouse (NASA LaRC), and Bruce Wielicki (NASA LaRC)

~85 assessment participants (TOA, surface, and both)

Local contributors: NIA: Laura Hinkelman
LaRC: Takmeng Wong, Lin Chambers, Juliet Pao, and Nancy Ritchey
SSAI: J. Colleen Mikovitz, Taiping Zhang, Danny Mangosing, Yan Chen, Walter Baskin, Churngwei Chu, Sherry King, Penny Oots, Tomeka Watkinson, and others

Radiative Flux Assessment Overview

Purposes:

- **Assess our current understanding and capability to**
  - ***derive TOA and surface radiative fluxes from analysis of satellite observations***
  - ***validate these fluxes with surface observations***
  - ***simulate these fluxes with models and assimilation***
- **Assess uncertainties and outstanding issues in flux estimation, particularly long-term variability**
- **Report methods and uncertainties for future IPCC reports on long-term data uncertainty.**
- **Develop climate system observation requirements for radiative fluxes and compare to current product accuracies.**

GEWEX RFA Activities to Date

- 1st workshop held (Oct. 2004 - Zurich, Switzerland)
  - Discussed general issues
  - Developed draft document
  - Assigned TOA and surface groups
- 2nd workshop held (Feb. 2006 - Williamsburg, VA)
  - Refined document outline
  - Defined surface/TOA actions and goals
  - Assigned chapter lead authors
- Web site operational
  - Includes document framework
  - Provides for ingest and download of all data sets
  - Many data sets ingested and ready for further analysis
- Results and analysis coming in
  - Several groups are working on analysis

GEWEX-RFA Data Archive

To date, data have been submitted from:

- ASRB
- BSRN
- CAVE
- CERES (ERBES, ERBE-like, and SRBAVG)
- DLR ISIS
- GFDL CM 2.1
- HIRS IR
- ISCCP-FD
- ScaRaB
- NASA/GEWEX SRB
- U. Maryland SRB (Z. Li)

Also non-standard surface data from Chuck Long.

GEWEX-RFA Results To Date

- Smith et al., 2006: ERB calibration intercomparison
- Raschke et al., 2006, GRL: SRB, ISCCP TOA comparison
- Zhang et al., 2006a,b: Near-surface meteorological and radiative properties
- SRB/CERES/ISCCP teams: Various intercomparisons
- Roesch et al. (not published): Sensitivity of monthly averages to treatment of data gaps
- Hinkelman et al. (not published): Preliminary time series analysis
- Freidenreich: GFDL model results vs. ISCCP-FD
- Schaaf: Surface albedo studies

Radiative Flux Assessment Next Steps

- Data ingest and analysis
  - Data product submittal largely finished.
  - Evaluation of ingested datasets against each other at different time and space scales is ongoing.
  - Collection, posting, discussion of analysis results

  ⇒ New section on web site listing relevant references
- Workshop to present results, coordinate chapters, discuss conclusions scheduled for June 25-27, 2007 at GISS
- Assembly of Radiative Flux Assessment draft report
  - Assemble draft chapters using submitted results
  - Coordinate results with chapter leads
- Collaborative draft assessment document (Aug 31, 2007?)
- Final document (December 2007?)

NASA/GEWEX Surface Radiation Budget (GEWEX SRB)

Version 2.8: July 1983 -- June 2005

Inputs: ISCCP DX radiances and cloud cover

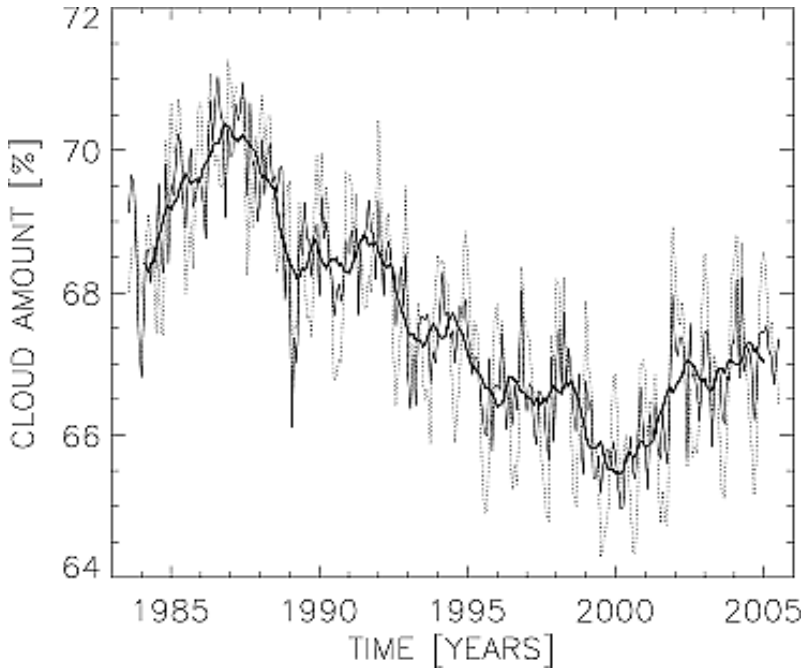
SW retrievals: Modified Pinker/Laszlo algorithm

Produced 3-hourly on a 1° pseudo equal area grid

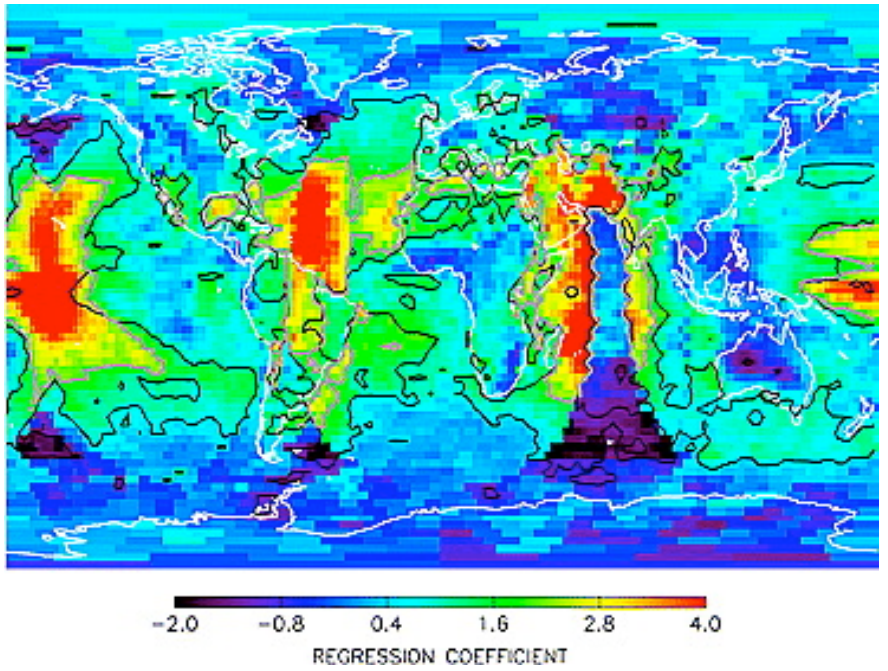
RFA version at 2.5° x 2.5°, monthly means

ISCCP Cloud Cover Artifacts

Mean Cloud Amount



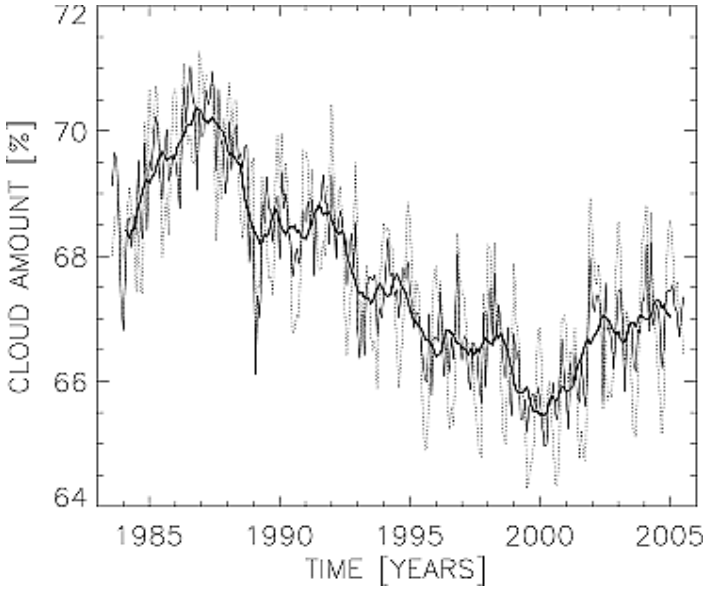
Local Correlation to Mean



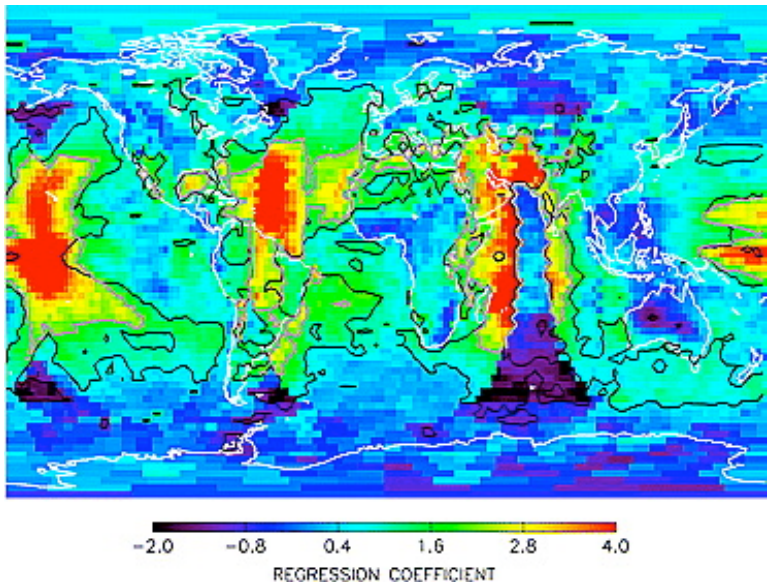
Evan, Heidinger, and Vimont, GRL, 2007.

ISCCP Cloud Cover Artifacts

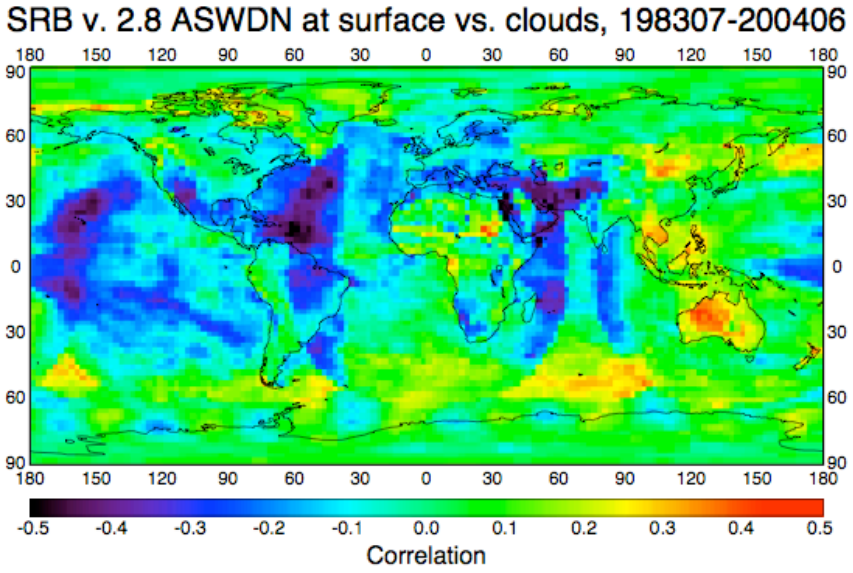
ISCCP Mean Cloud Amount



Local Correlation to Mean

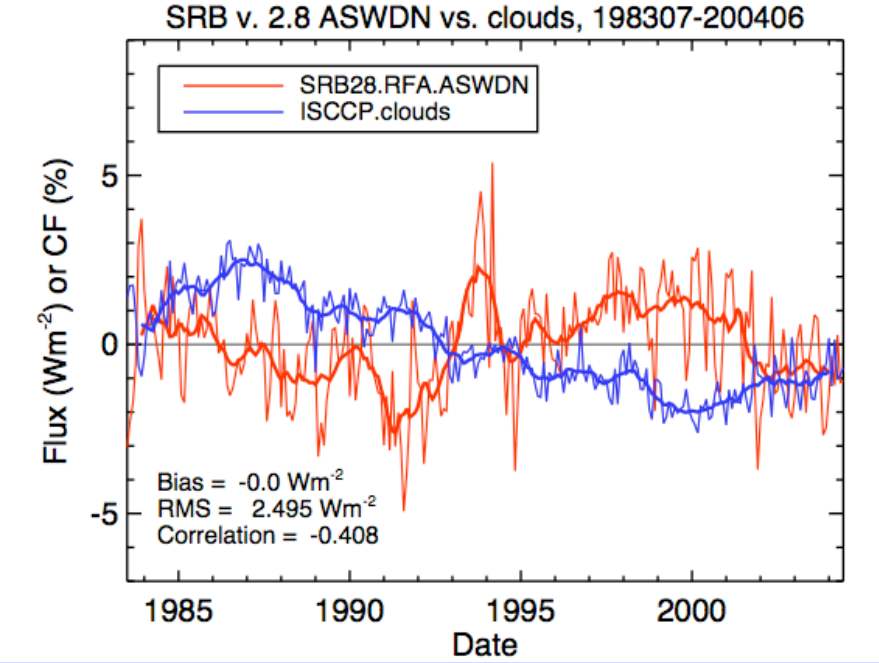


SRB



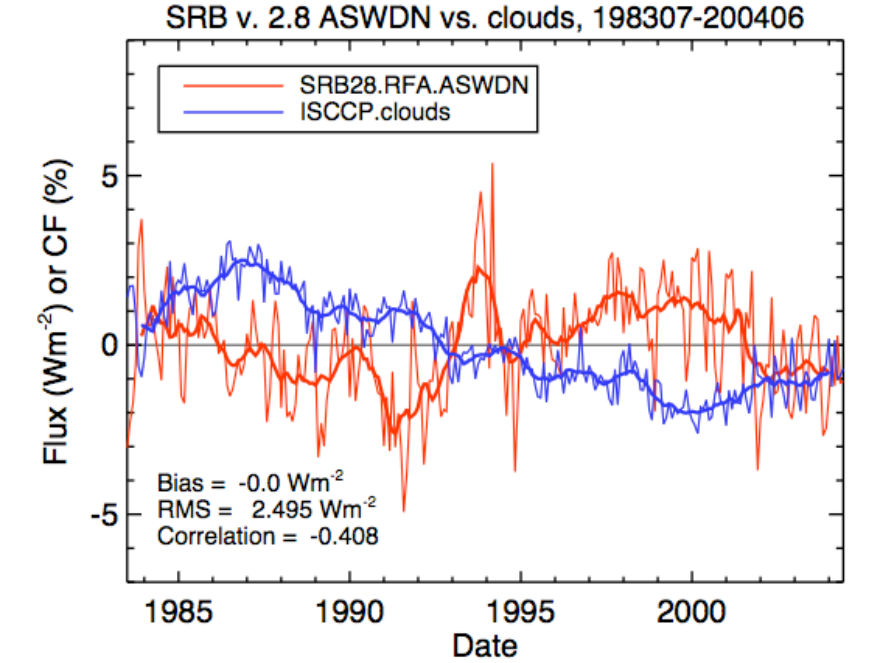
ISCCP Cloud Cover Artifacts

SRB Mean Downward SW Flux

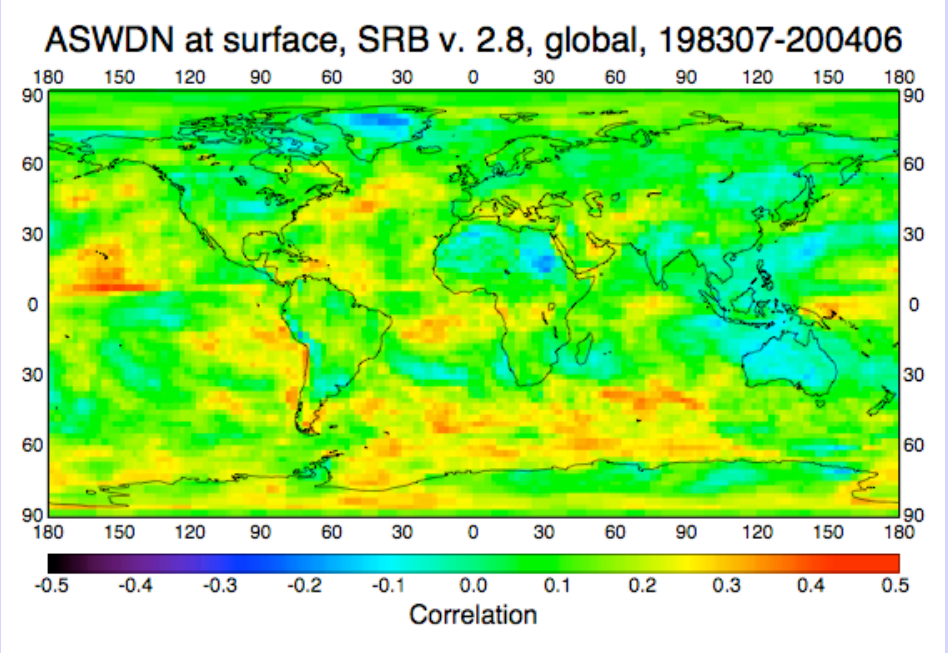


ISCCP Cloud Cover Artifacts

SRB Mean Downward SW Flux

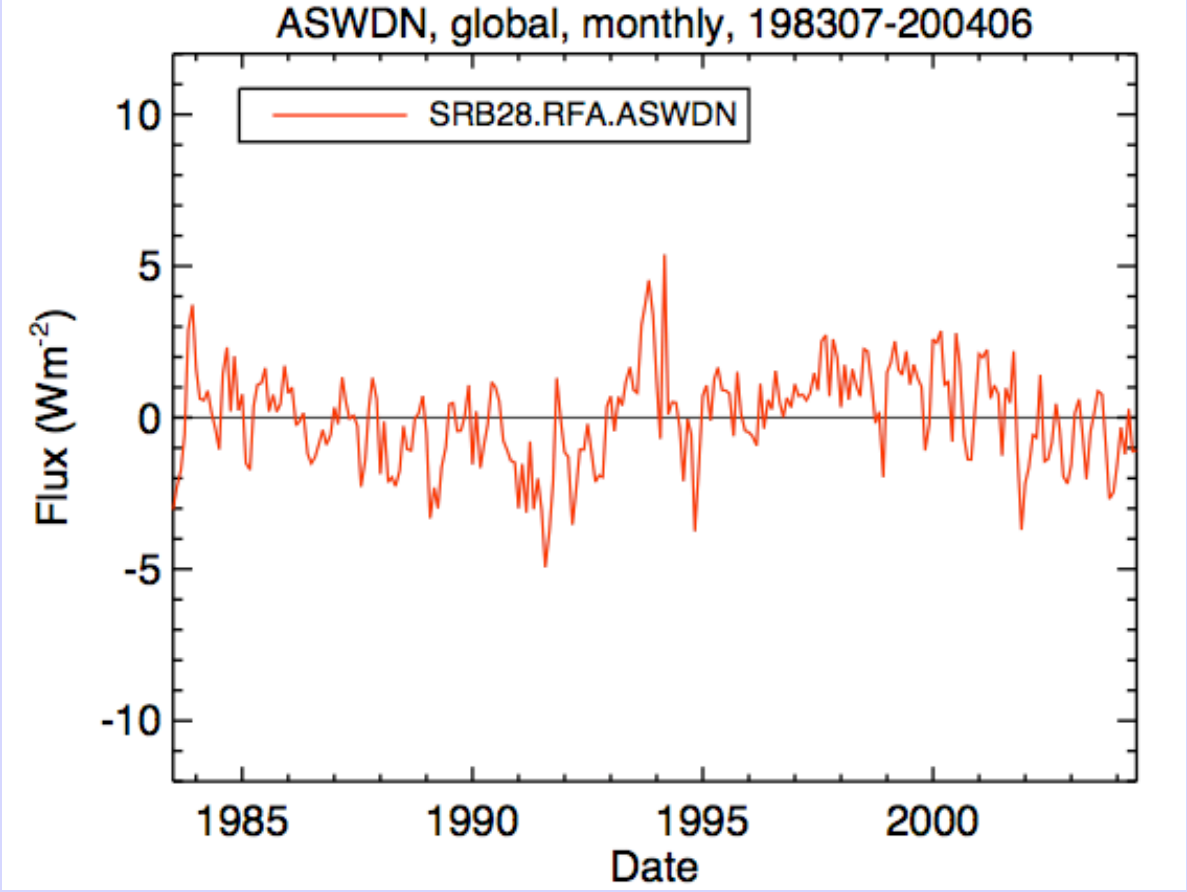


Local Correlation to Mean



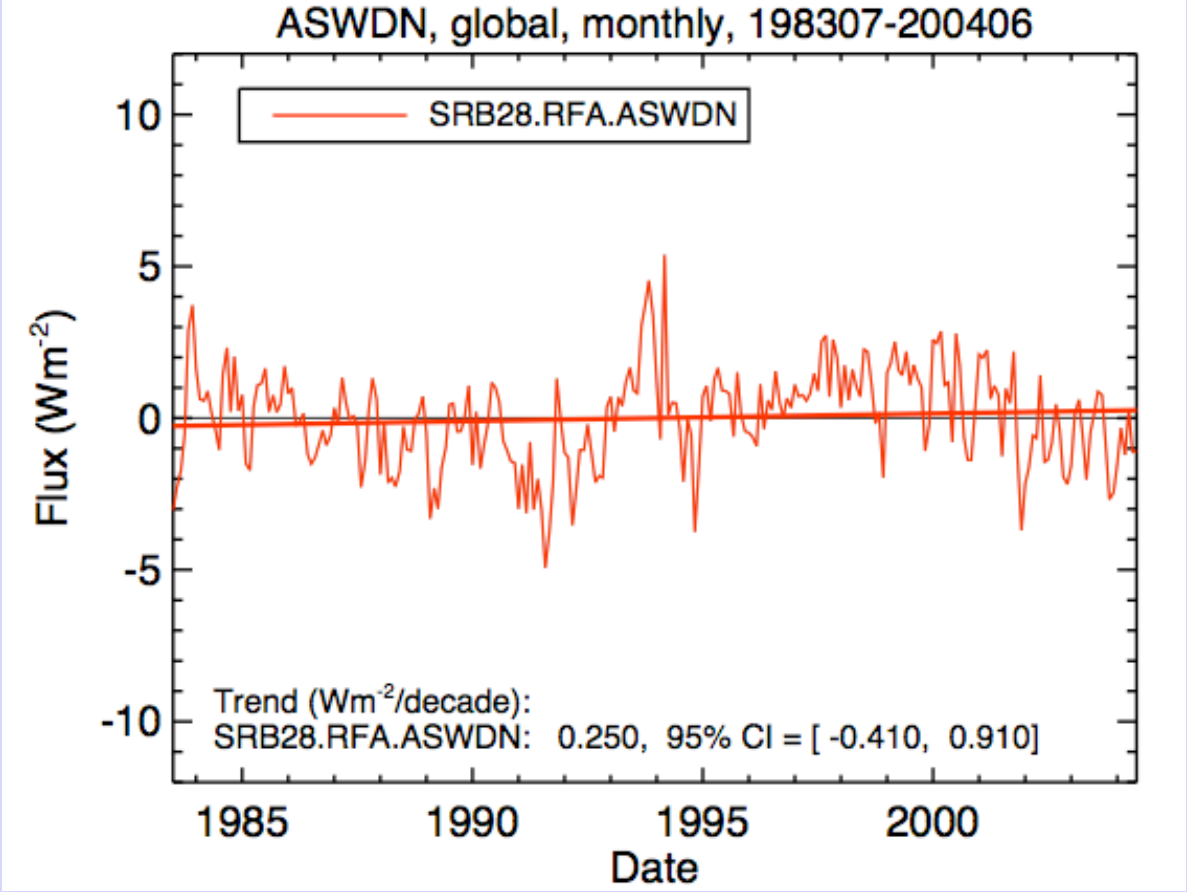
ISCCP cloud cover artifacts do not dominate global mean SW downward flux at the surface from SRB.

GEWEX-SRB Global Mean Anomaly



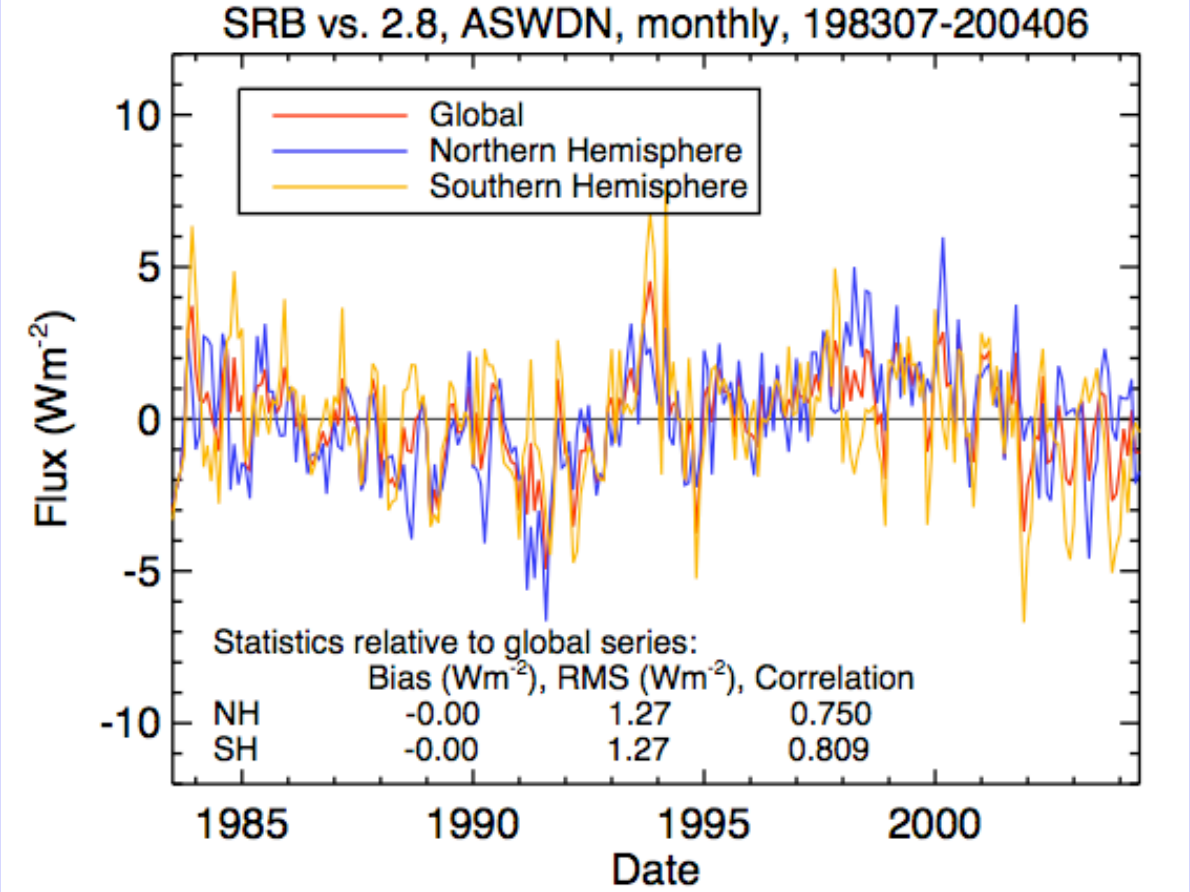
- “Dimming” and “brightening” trends apparent.
- Data has nonzero autocorrelation. Use techniques described in Weatherhead et al., 1998, for analysis.

GEWEX-SRB Global Mean Anomaly



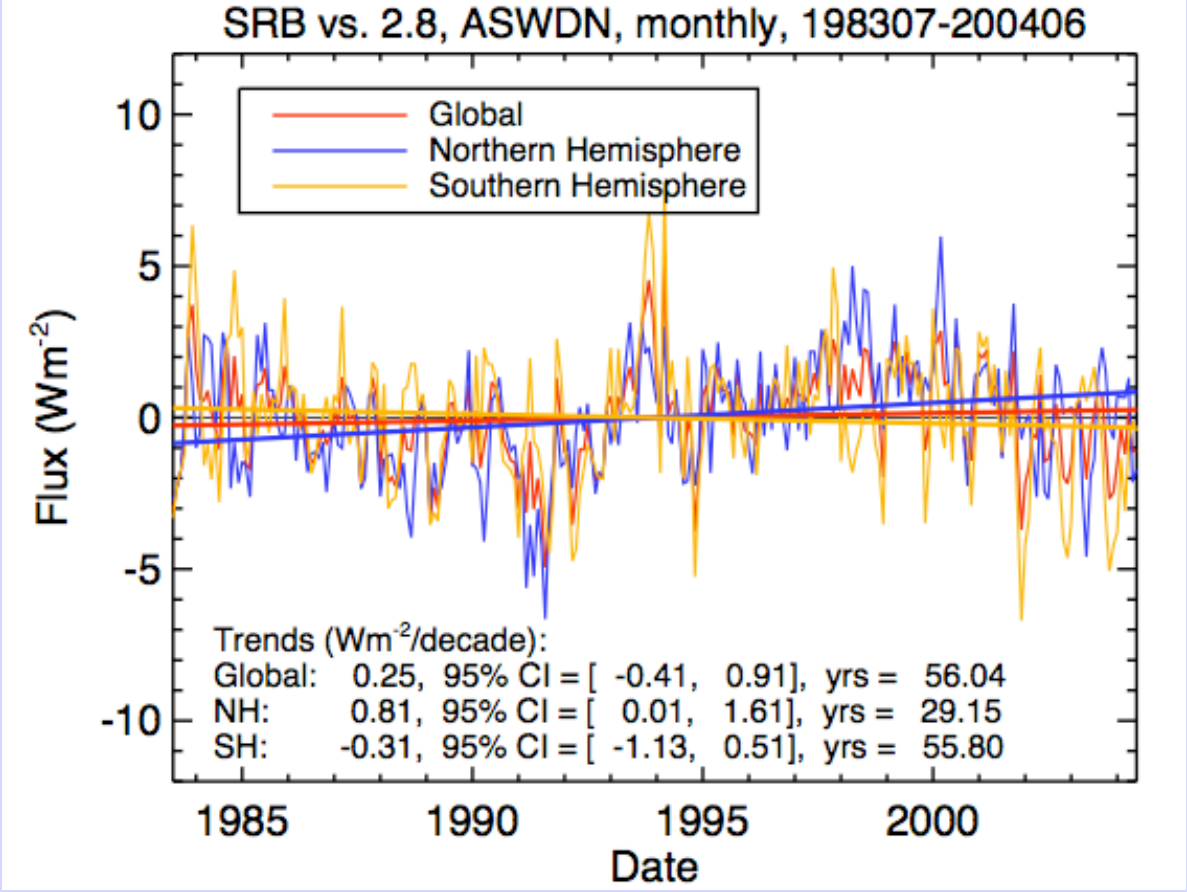
- Small positive trend is detected but insignificant.
- Time to significance for this trend would be 56 years.

GEWEX-SRB Global Trends



- All time series are reasonably well correlated.

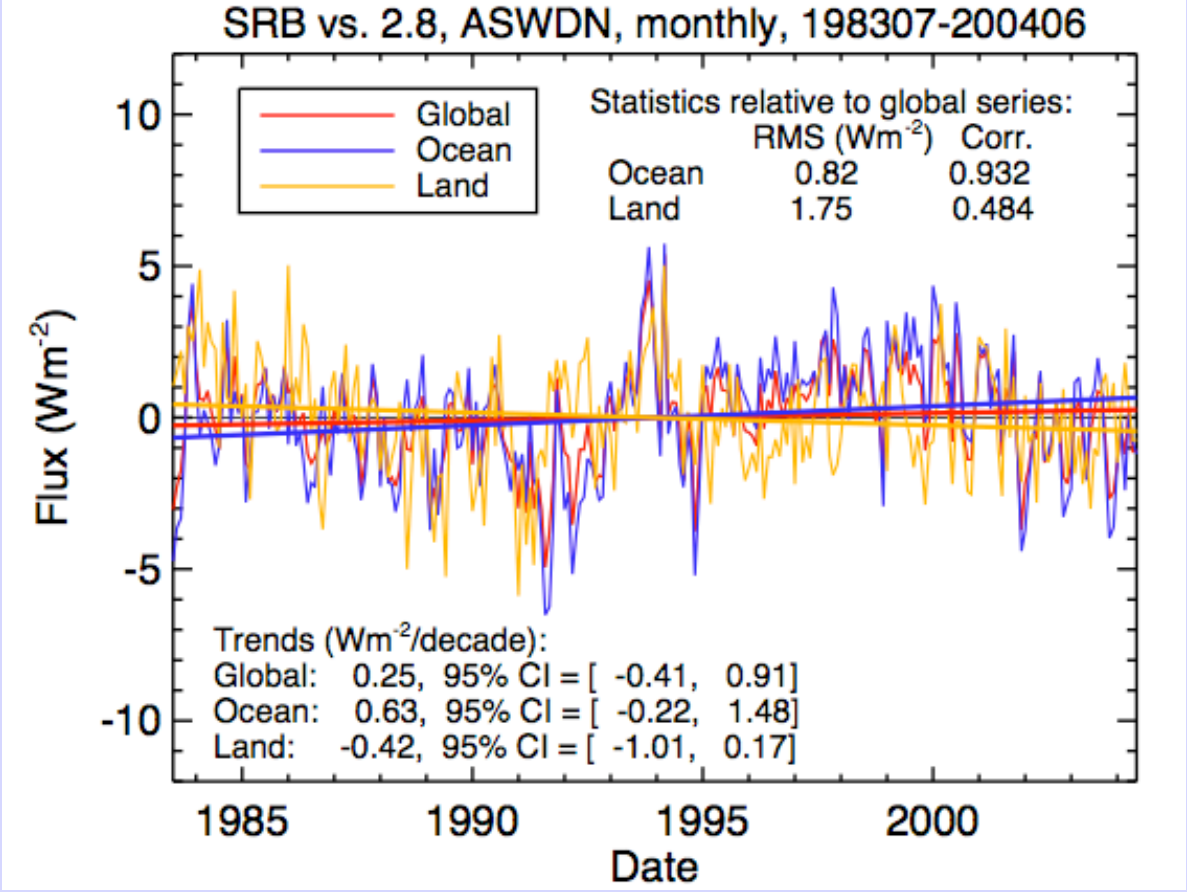
GEWEX-SRB Global Trends



- Trend in NH is stronger, approaching significance.
- NH and SH contribute equally to global trend.

➡ Fluxes from Southern Hemisphere also important.

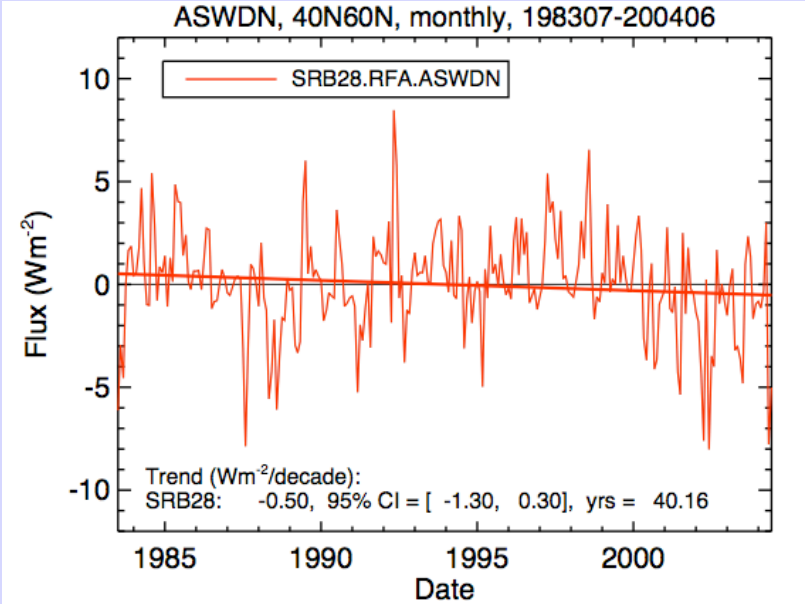
GEWEX-SRB Global Trends

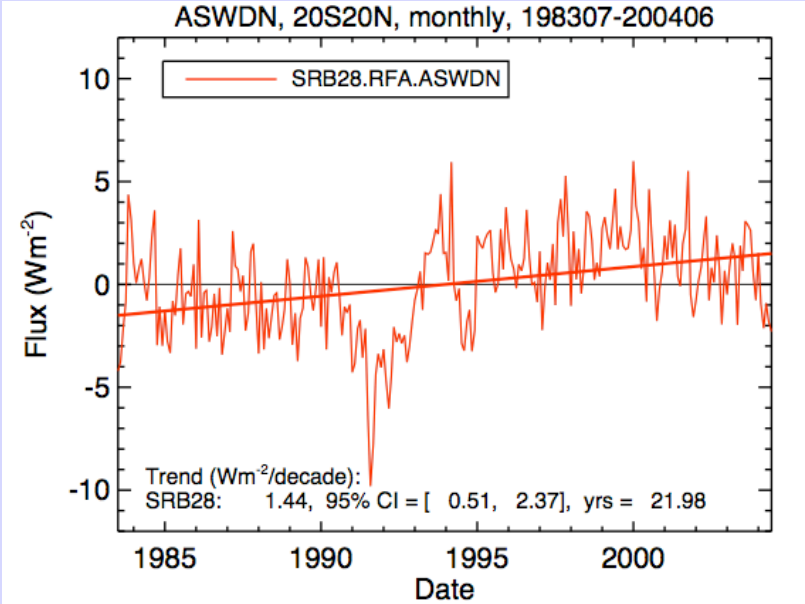


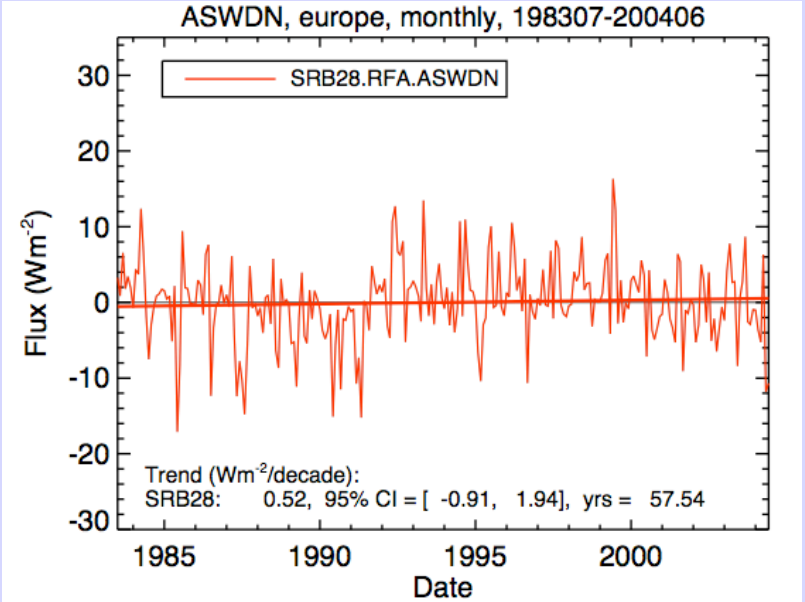
- Land signal less well matched to global signal.
- Global trend more strongly influenced by ocean.

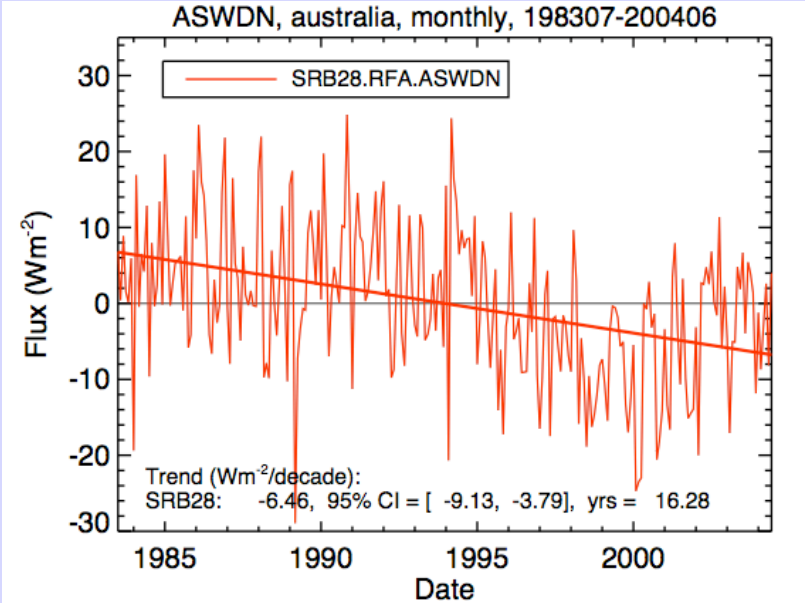
➡ Ocean data is crucial to understanding globe.

GEWEX-SRB Results









CERES SRBAVG-GEO (SRBAVG)

Inputs: CERES and geostationary satellite radiances, MODIS/GEO cloud properties

SW retrievals: Staylor/Gupta and Li/Leighton parameterizations

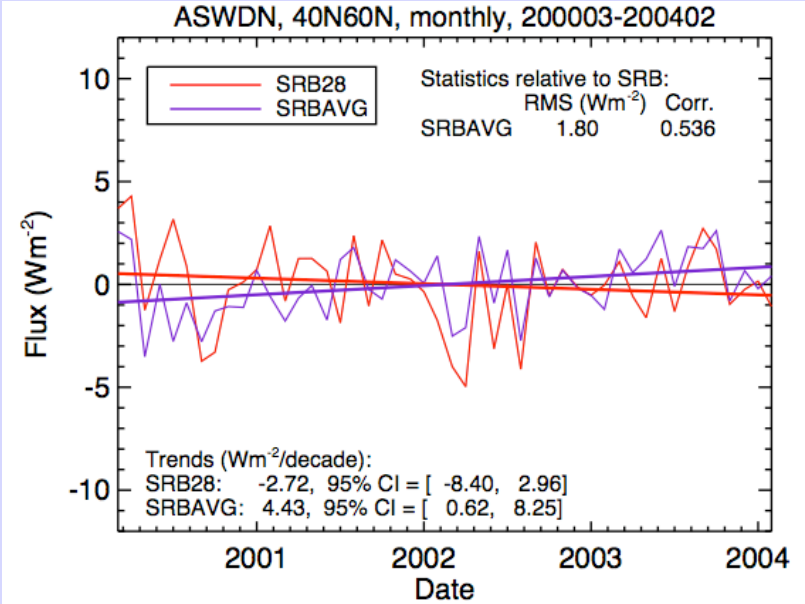
Output: monthly on a 1° pseudo equal area grid

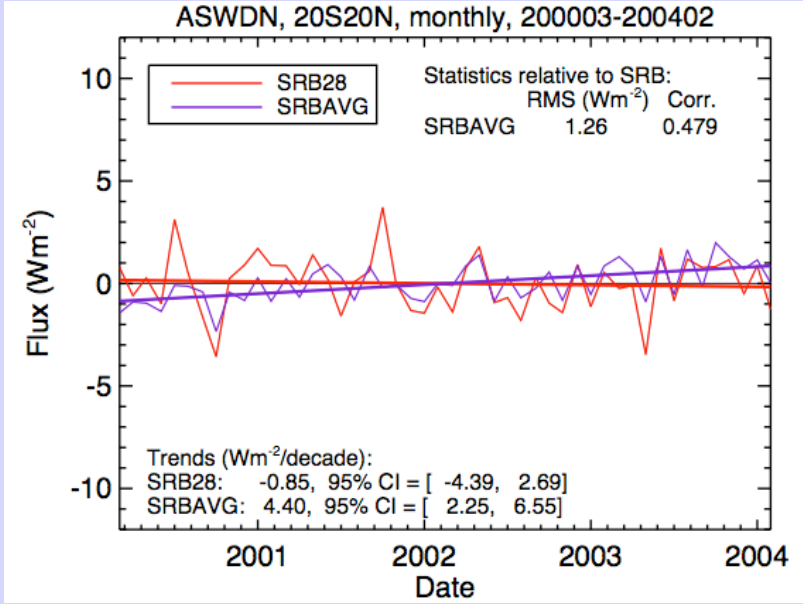
RFA version at 2.5° x 2.5°

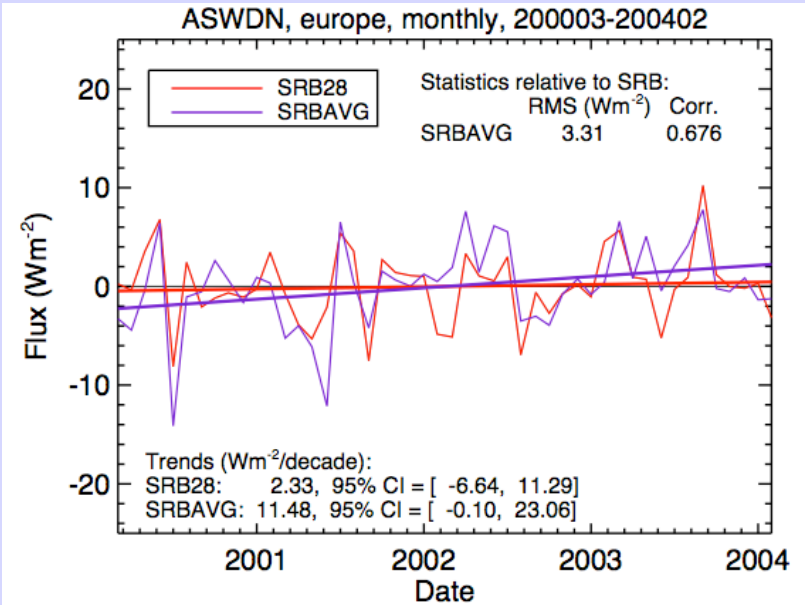
Edition 2C: March 2000 -- June 2005

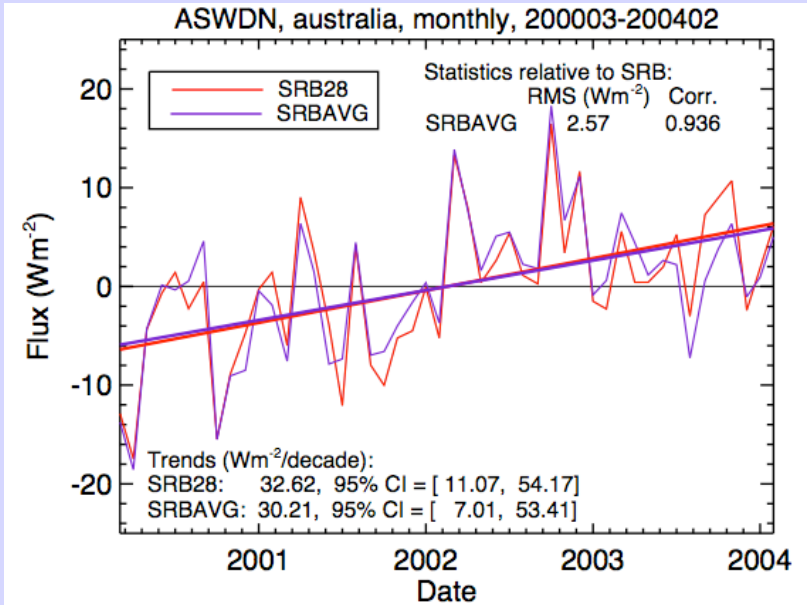
* GEO data renormalized to match CERES *

SRB-SRBAVG Comparisons









Conclusions

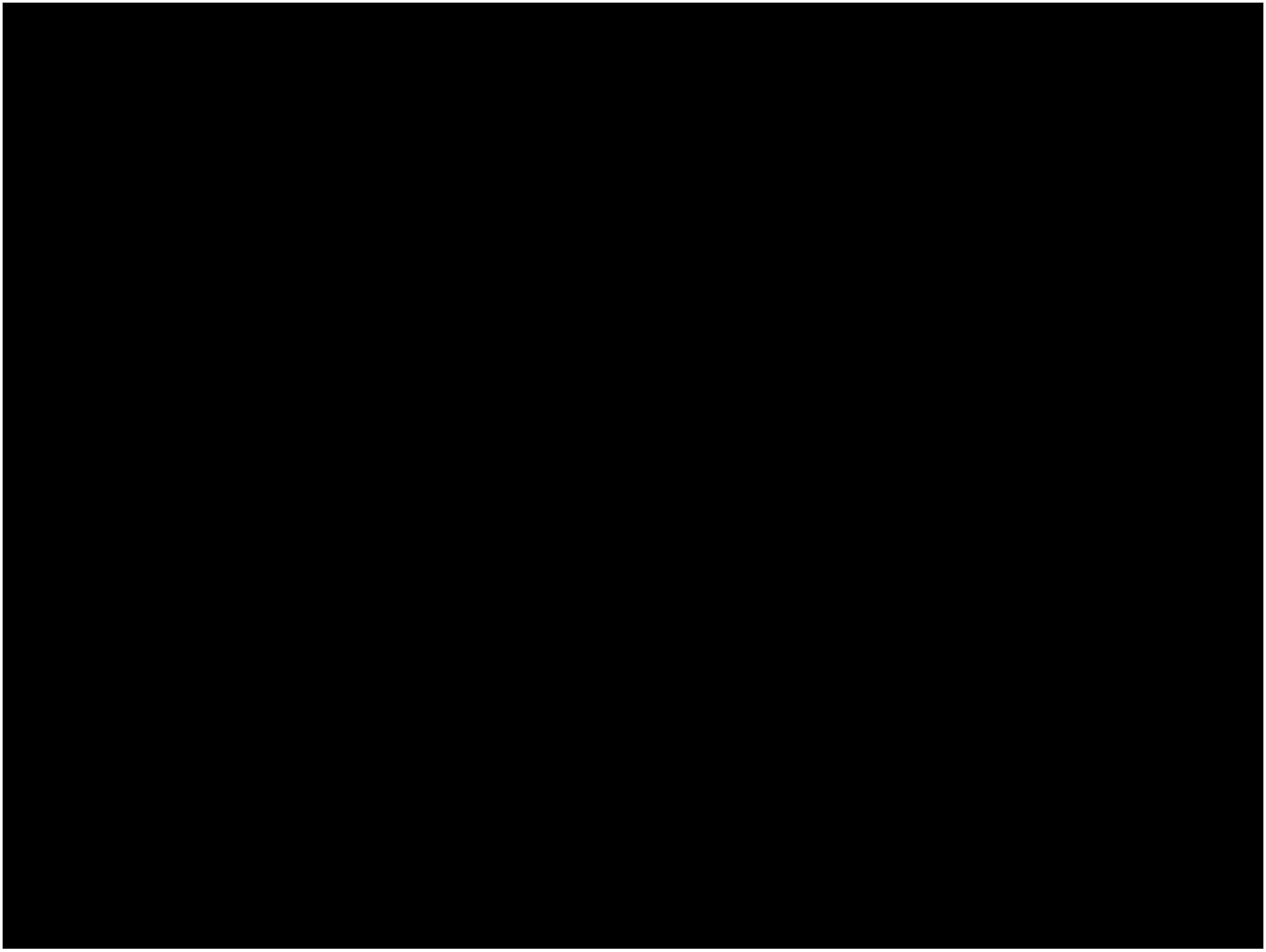
SRB SW downwelling global mean time series

- **is not dominated by the ISCCP cloud artifacts.**
- **shows pattern of "dimming," "brightening," and then "dimming" expected from surface measurements.**

Oceans and the Southern Hemisphere contribute significantly to global SW flux trends. ⟹ Need more surface measurement sites in these areas to determine worldwide trends.

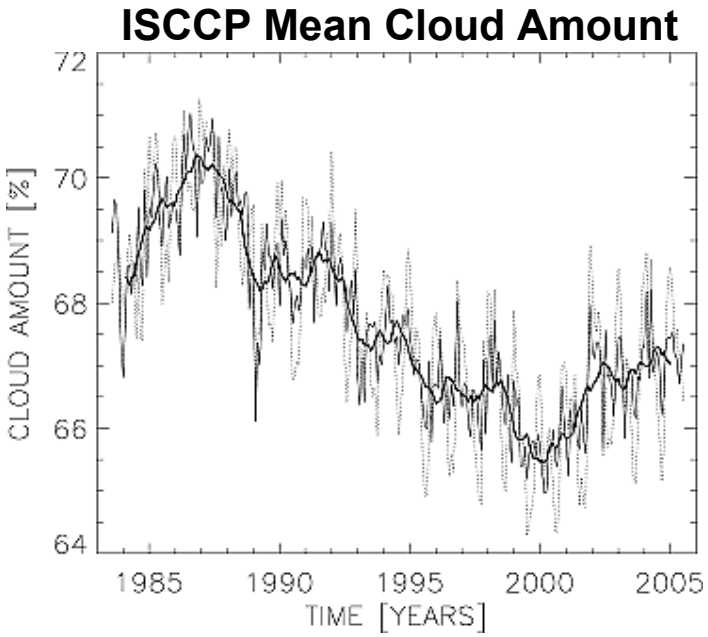
Most detected trends are small and statistically insignificant except in smaller regions for short time periods.

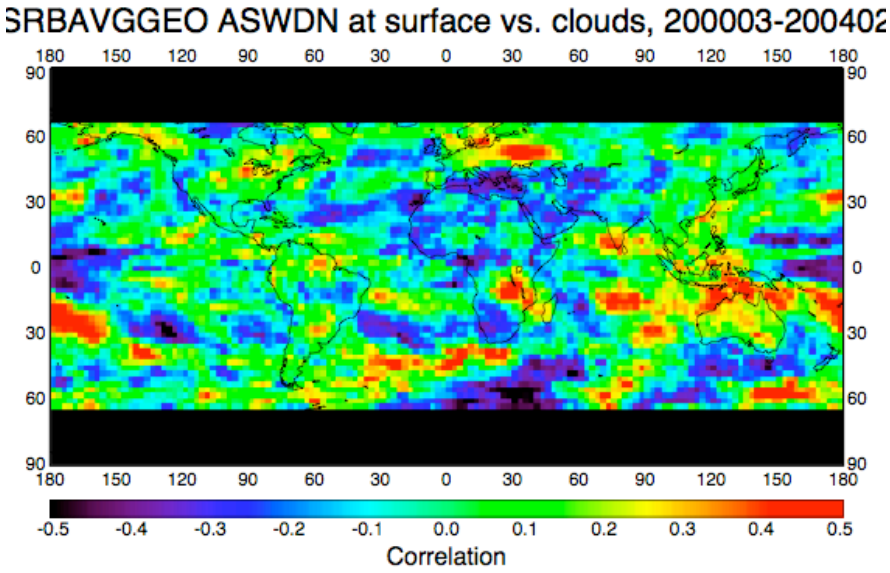
CERES SRBAVG and SRB time series are similar when the anomalies are large (10-20 Wm^{-2}), can differ substantially when anomalies are small (2-5 Wm^{-2}). ⟹ More work needed to improve ISCCP record, tie ISCCP results to newer measurements, and improve surface flux retrieval methods.

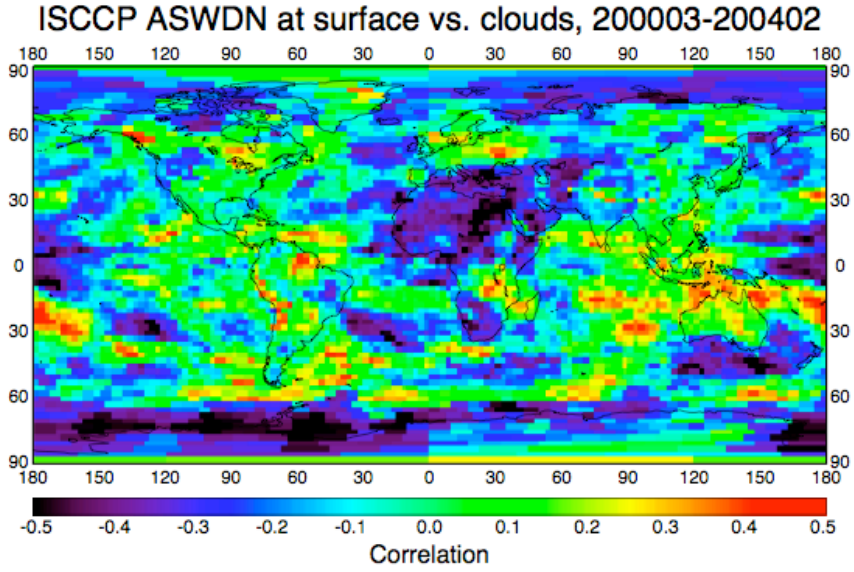


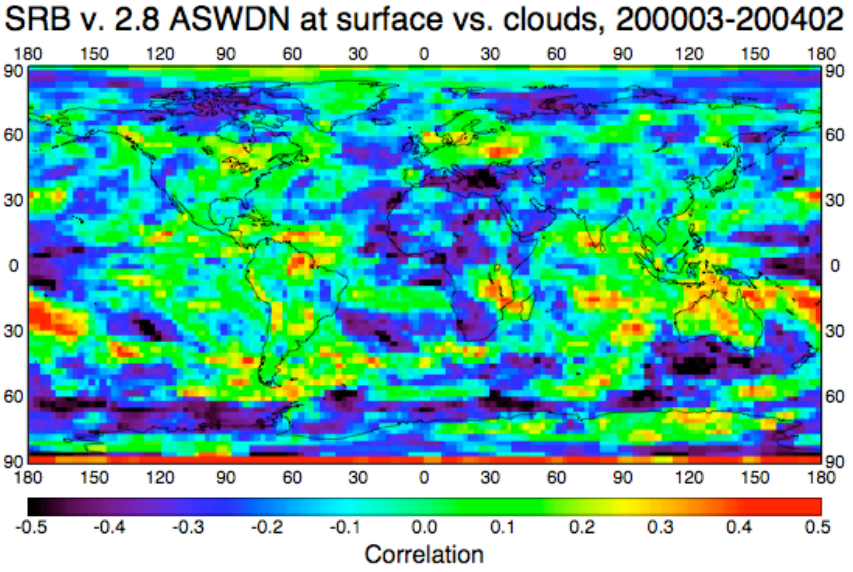
Backup slides

ISCCP Cloud Cover Artifacts -- 2000-2004



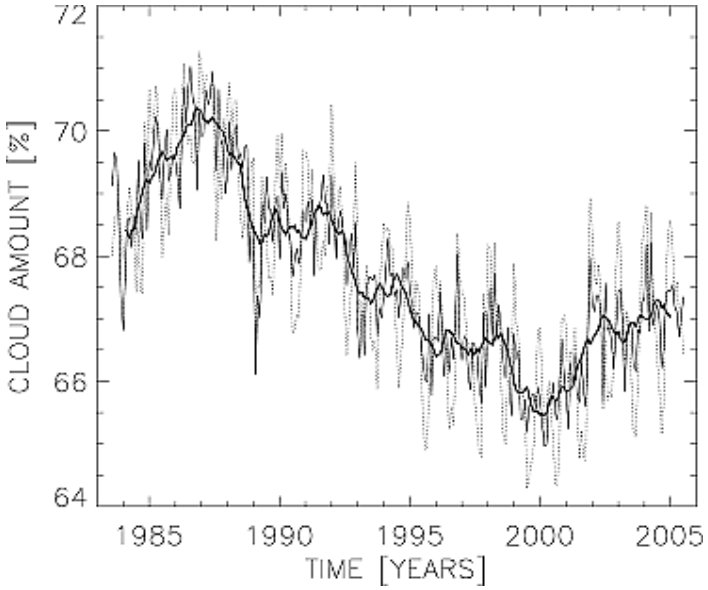




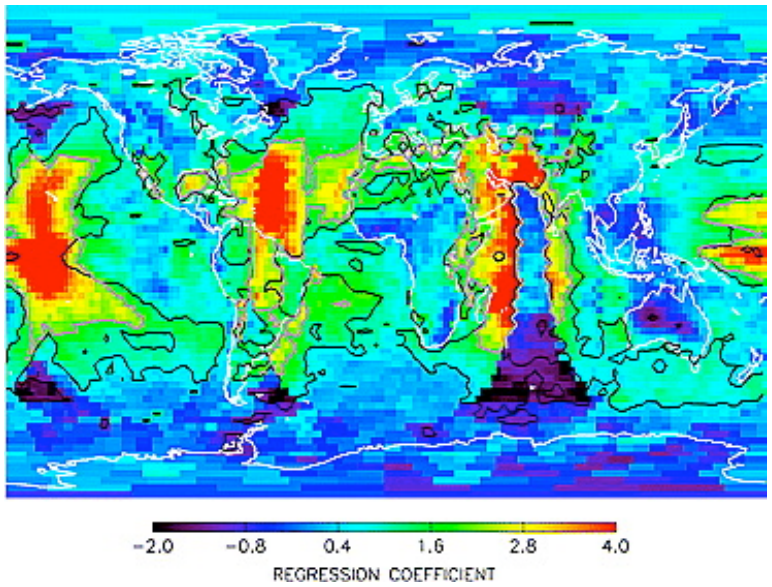


ISCCP Cloud Cover Artifacts

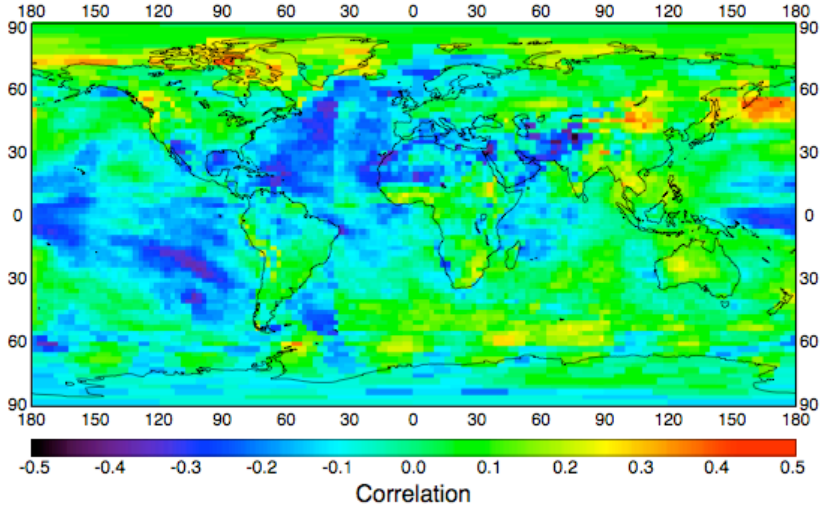
ISCCP Mean Cloud Amount



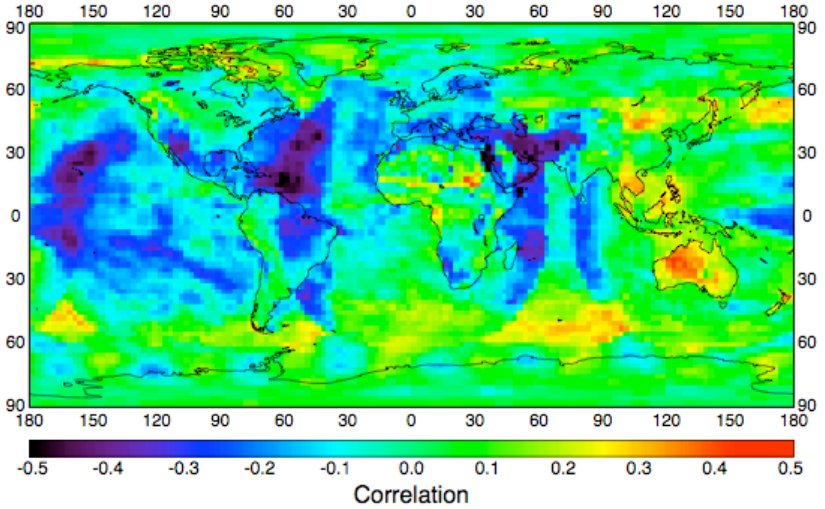
Local Correlation to Mean



ISCCP ASWDN at surface vs. clouds, 198307-200406

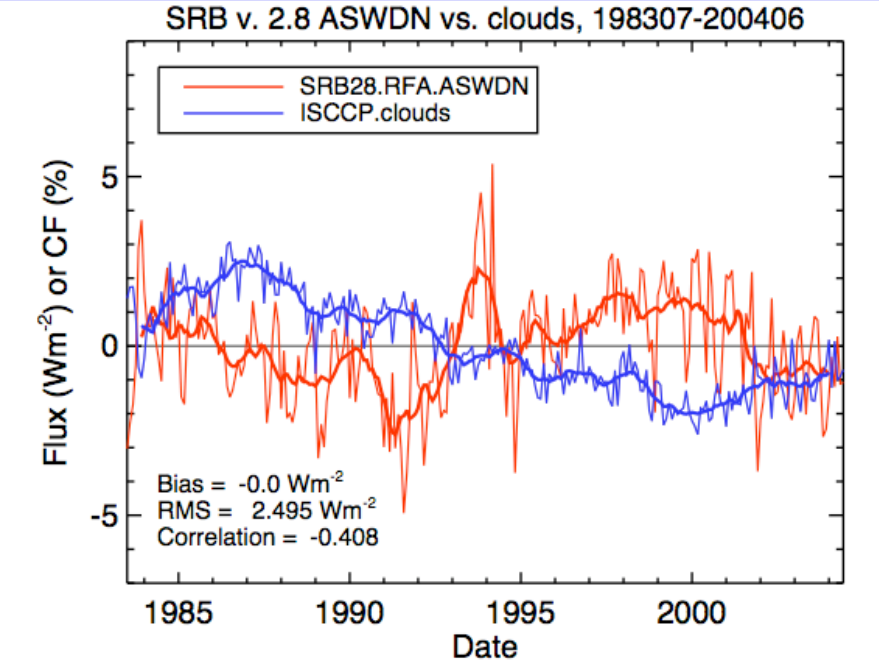


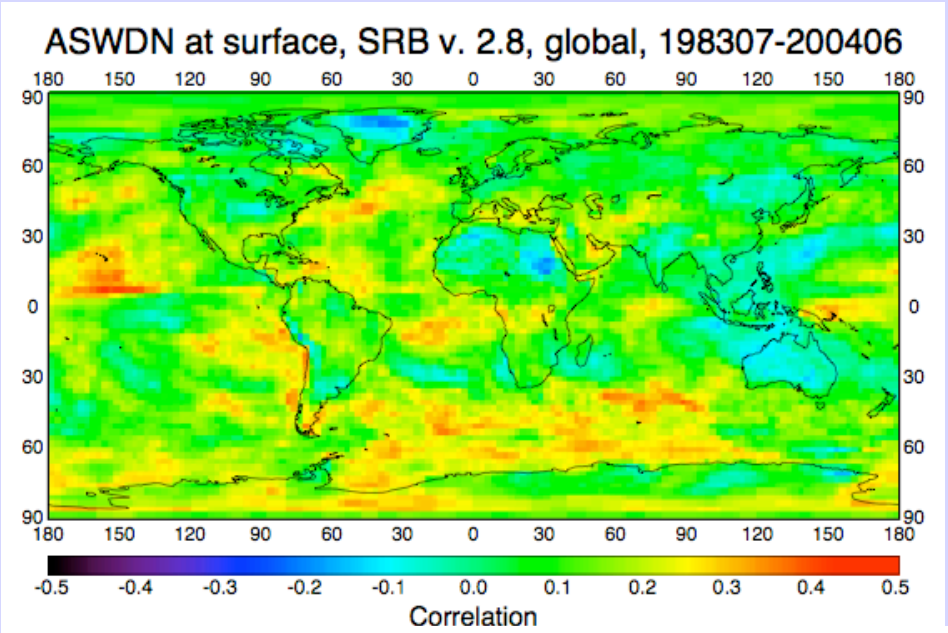
SRB v. 2.8 ASWDN at surface vs. clouds, 198307-200406



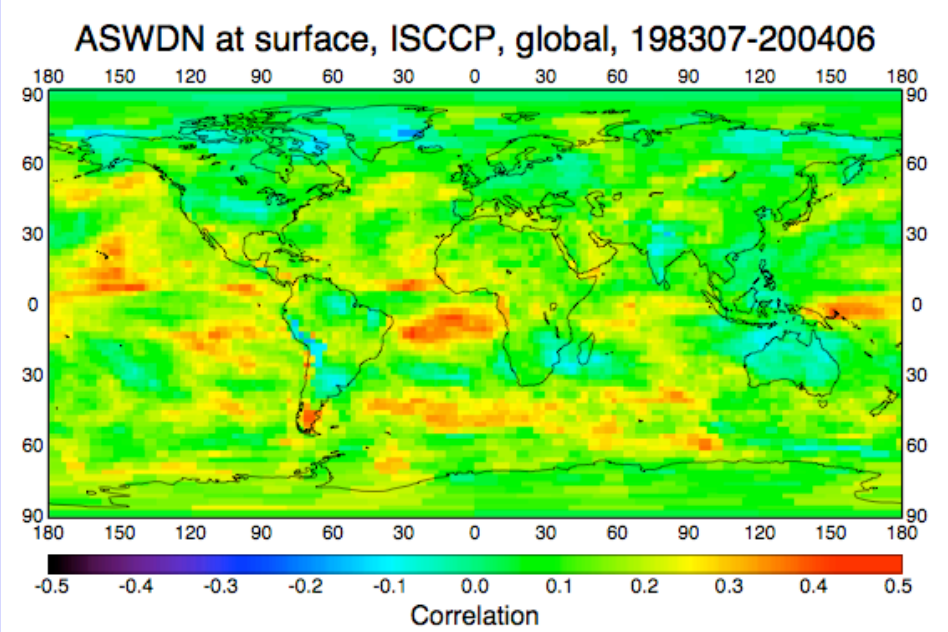
ISCCP Cloud Cover Artifacts

SRB

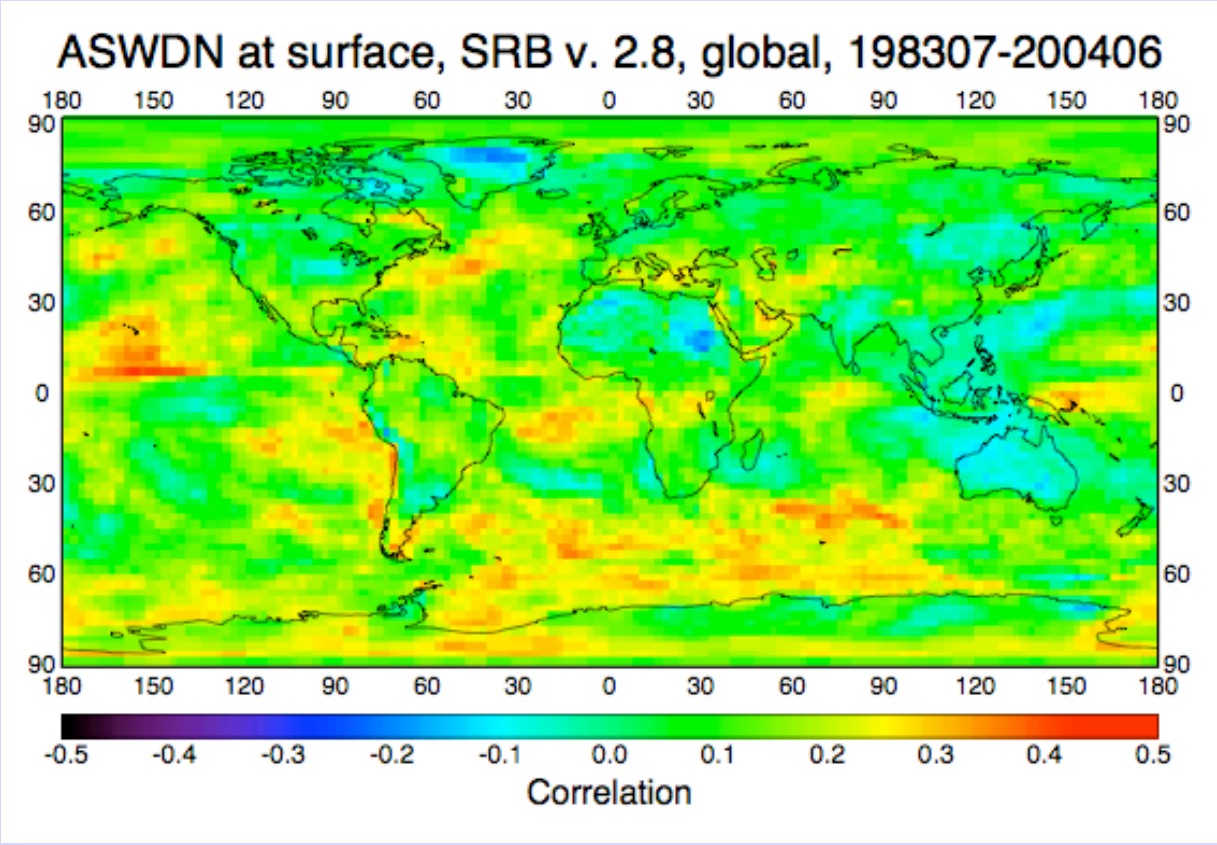




ISCCP

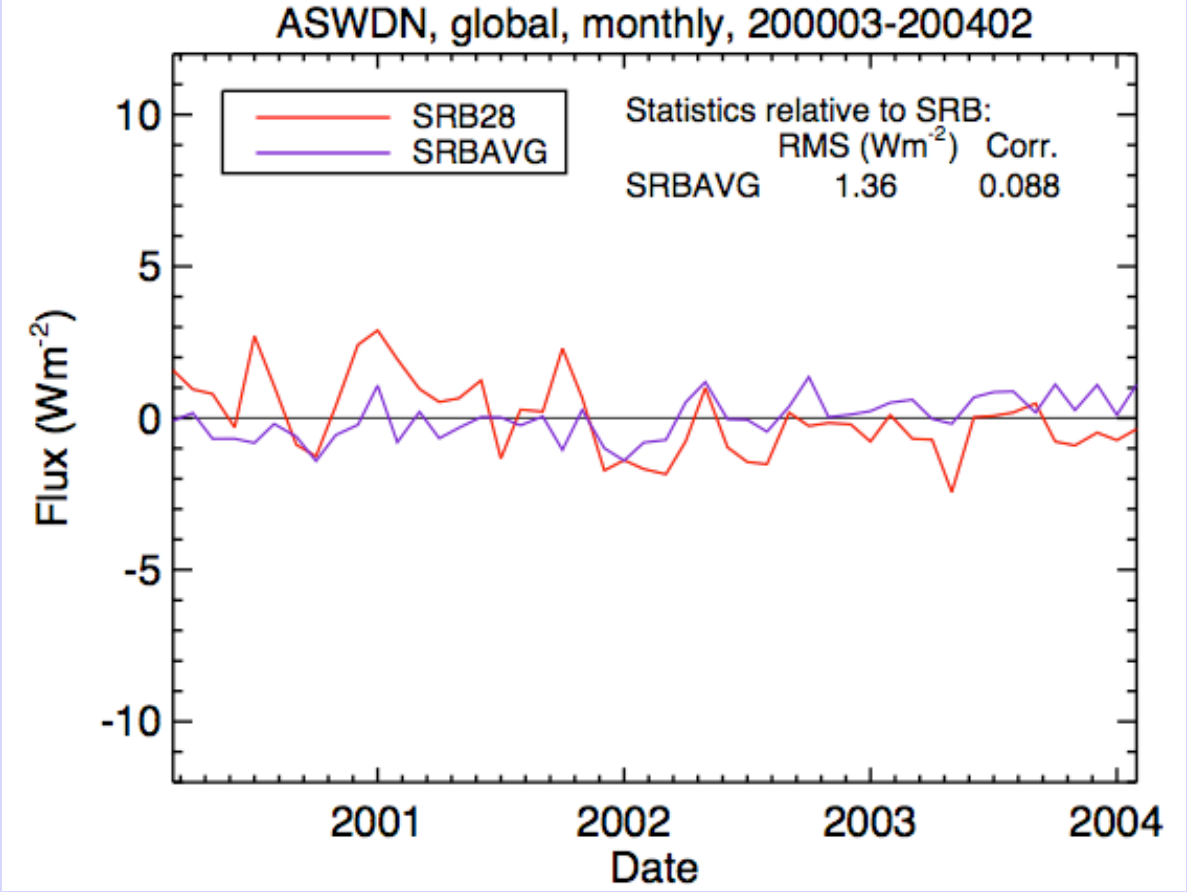


Correlation with SRB Global Mean



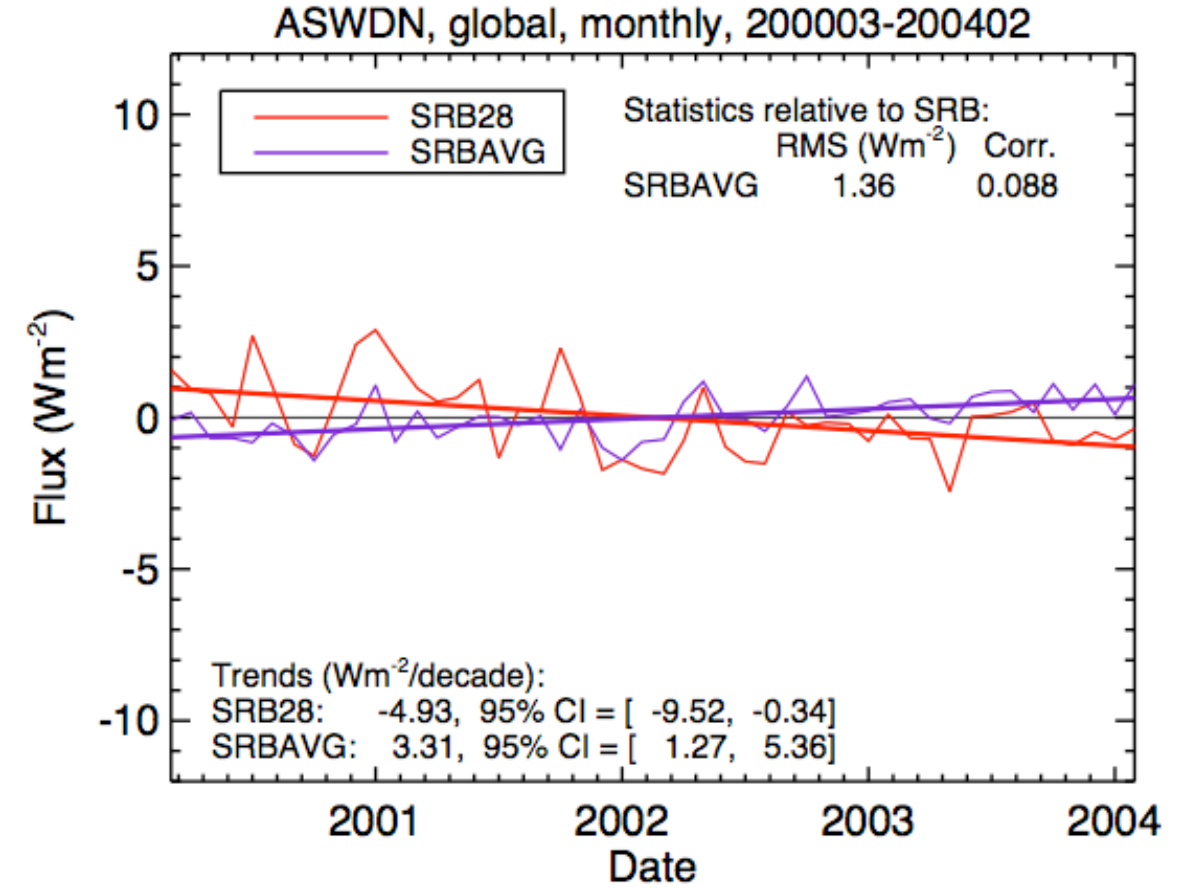
SRB mean downwelling shortwave flux not dominated by ISCCP artifacts.

SRB and SRBAVG Global Means



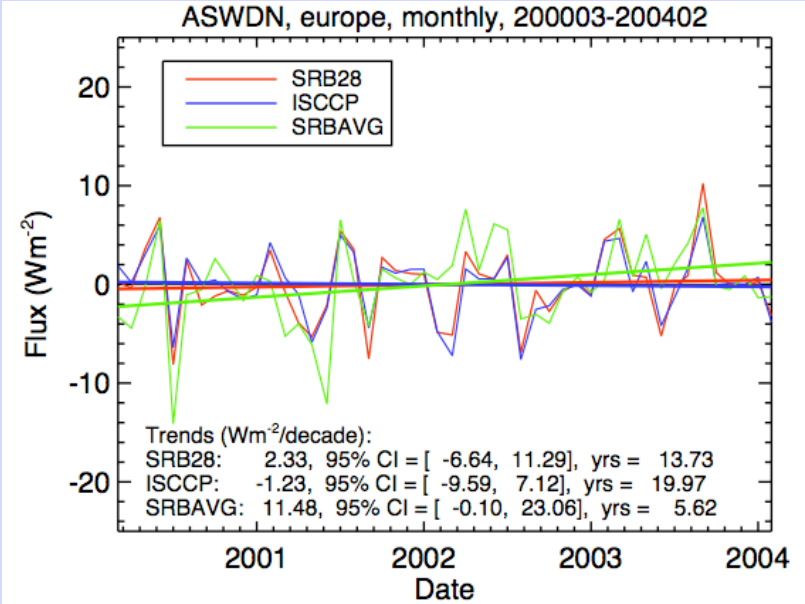
- SRB and SRBAVG nearly uncorrelated.
- Magnitudes of fluctuations are small.

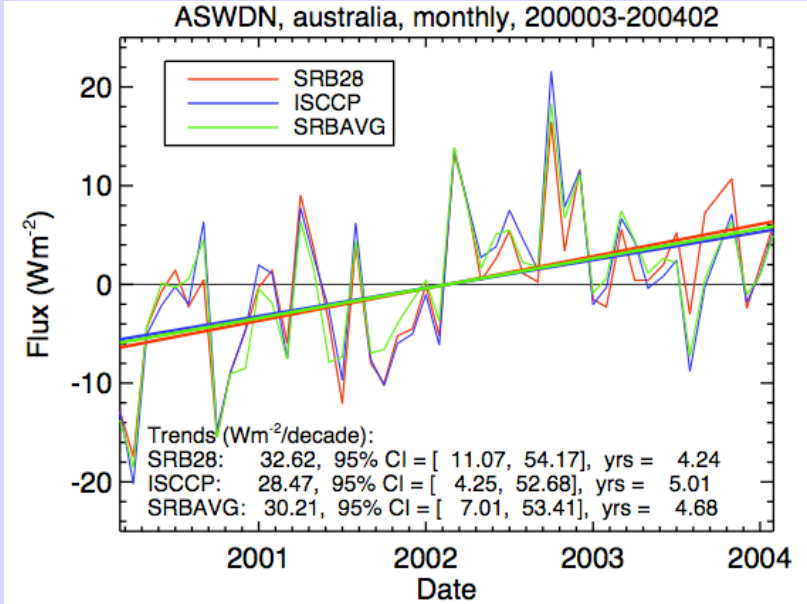
SRB and SRBAVG Global Means

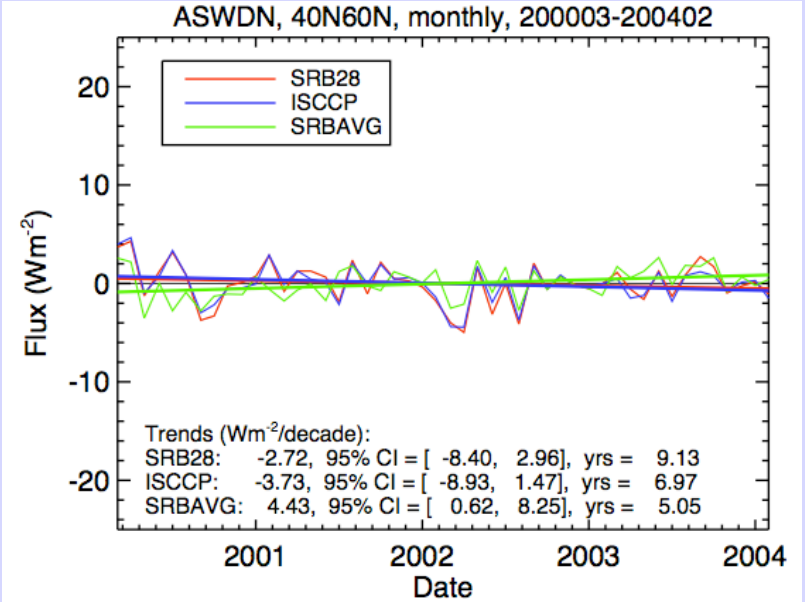


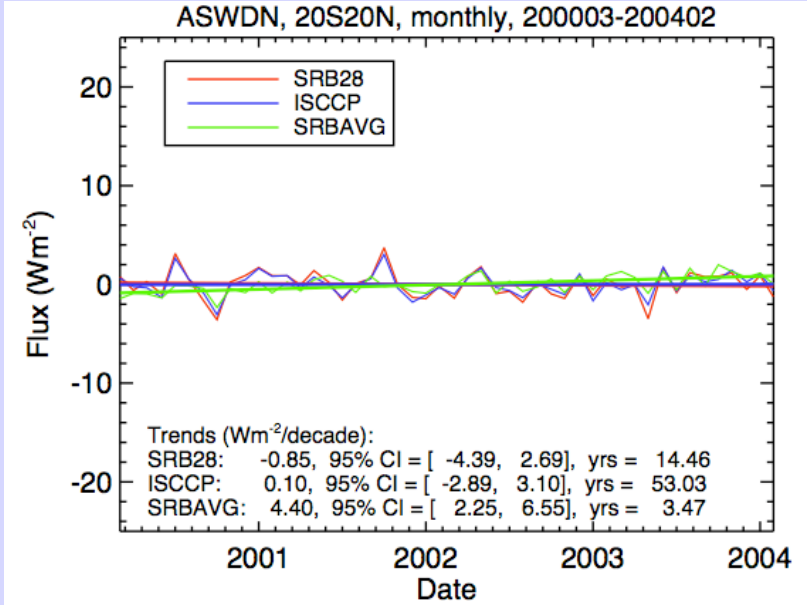
- SRBAVG trends very different from SRB.
- Significance times not meaningful, since trends will change.

SRB-ISCCP-SRBAVG Comparisons









Conclusions -- SRB

SRB downwelling SW global mean time series shows pattern of “dimming,” “brightening,” and then “dimming” expected from surface measurements.

Oceans and the Southern Hemisphere contribute significantly to global SW flux trends. → Need more surface measurement sites in these areas to determine worldwide trends.

Most detected trends are small and statistically insignificant except in smaller regions.

Conclusions -- SRBAVG

Large trends are detected in some regions for the CERES time period -- probably due to short record.

SRBAVG and SRB/ISCCP time series are similar when the anomalies are large (10-20 Wm^{-2}), can differ substantially when anomalies are small (2-5 Wm^{-2}).

More work needed to improve ISCCP data, tie ISCCP to newer measurements.